MIDDLE NOATAK RIVER MOOSE CENSUS-NOVEMBER 1995

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INTRODUCTION

The National Park Service (NPS) and the Alaska Department of Fish and Game (ADF&G) conducted a moose census in the western portion of the Middle Noatak Moose census area in early November 1995. Survey conditions were similar to 1993 with respect to snow cover; moreover, an extended period of cold, clear weather in November permitted agency personnel to complete 3 stratified, random sample surveys within Unit 23 (Upper Kobuk River, Kobuk/Salmon River, Middle Noatak River). Detailed background information about the Noatak River moose population and previous censuses can be found in Dau et al. (1994) and Shults et al. (1995).

METHODS

We used the stratified random sampling technique developed by Gasaway et al. (1986) to estimate fall (i.e. post-hunt) moose abundance and composition in the western portion of the middle Noatak River census area (Fig. 1). Sample unit boundaries were identical to the 1993 and 1994 units. However, we did not stratify sample units in the field during 1995 due to the absence of a suitable stratification airplane. Instead, we used the results of the 1993 stratification as a basis for randomly selecting sample units within each strata. We chose the 1993 stratification because the 1995 snow conditions were more similar to 1993 than the only other year we had stratification results for the area (i.e. 1994). Sample units were surveyed using 4 PA-18 Super Cubs (1-ADF&G and 3-Charter). Detailed survey methods can be found in Dau et al. (1994). Population parameters were estimated using the computer program MOOSEPOP where variance was not pooled across the strata, and estimates are reported with their corresponding 80% confidence intervals (DeLong and Reed, no date).

RESULTS

We conducted the census between 9 November and 11 November 1995 (Table 1). Sample units were surveyed in 44.8 flight hours. Participants in the survey were local agency biologists with prior moose survey experience.

Stratification and Sample Units

The western survey area is 858 mi^2 (2,222 km^2) and has been delineated into 68 sample units. The *a priori* stratification, using the 1993 stratification resulted in 23 low, 28 medium, and 17 high density units (Fig. 2). We surveyed 26 of 68 units (38%; area = 331 mi^2) and completed intensive surveys for sightability correction factors in 19 of those units surveyed (10 of 13 high, 7 of 9 medium, and 2 of 4 low density units (Table 2). The mean standard search intensity was 3.9 min/mi^2 (range 2.0-8.6 min, SD = 1.5 min). Sightability estimates were 100%, 95%, and 93% for low, medium, and high density sample units, respectively.

Population Estimation and Composition

MOOSEPOP population estimates and composition estimates are summarized in Tables 3-8. The estimate of 1,141 moose (80% CI ± 23%) results in a density estimate of 1.3 moose/mi^2 (0.5 moose/km^2) (Table 3). We counted 544 moose classified as 110 bulls, 360 cows, and 74 calves. Bull, cow, and calf estimates were 252, 735, and 154, respectively (Tables 4, 5, and 6). The estimated bull:cow ratio was 34:100 (80% CI ± 13%) and the estimated calf:cow ratio was 21:100 (80% CI ± 22%)(Tables 7 and 8). Bull antler size classes were estimated to be 22% small, 38% medium, and 40% large. Cows were estimated to comprise 64% of the population.

DISCUSSION

Population Parameters

The 1995 middle Noatak River moose population estimate is higher than 1994, but the increase is insignificant. Overall, the survey data collected since 1993 indicate that the population is fluctuating annually around a mean, post-hunt population of 1,100 moose (Table 9). Following rapid expansion of moose into northwest Alaska in the middle of the century, and the subsequent growth of the Noatak population throughout the 70's and 80's, the population declined sharply after the severe 1990-91 winter and has continued to slowly decline (Dau et al. 1994). A high mortality rate (i.e. 20-29% annually) and poor productivity(mean = 24 calves:100 cows, 1986-1995) are two factors which have contributed to the decline. The roles that nutrition and disease play are uncertain; however, winter severity, especially snow depth, has certainly caused decreased survivorship (e.g. winter 1990-91).

Given the survey data and trends in moose harvest, no further harvest restrictions are recommended at this time. The management goal of maintaining 1 moose/mi^2 is being met. Although, the second objective, to maintain the bull:cow ratio at 40 bulls:100 cows is not being met, a further reduction or cessation of fall hunting, which targets primarily large bulls, are the only alternatives to increase this ratio through active management. The loss of hunting

opportunity to maintain or increase the bull: cow ratio, given the low abundance of moose due primarily to "natural" factors (i.e. high natural mortality/poor productivity), may not be justified. Furthermore, future harvest restrictions should focus on protecting cows from overharvest during the winter hunting season. Recognizing this need, the first step was taken in 1993 to shorten the cow season within the Noatak drainage. In the future, managers and users alike may need to implement further restrictions to maximize the number of reproducing cows in the population by protecting them from harvest.

The dynamic nature of moose populations demands that future moose management decisions within the Noatak drainage, and elsewhere in Unit 23, be based on management plans. Given the wildlife population management guidelines set forth by NPS policy and the complexity of dual management, enhancing moose abundance with manipulative predator management within the Noatak National Preserve is unlikely. The charge of regional wildlife managers and user groups should be to develop a long-term monitoring program to gather data that support decisions that are tied to goals and objectives. A regional approach will prevent other areas from becoming overrun with displaced hunters when onerous hunting restrictions leave them no choice but to search out new hunting opportunities. In summary, with lightly harvested predator populations, and a low-density moose population in the Noatak, moose abundance may remain chronically low for an extended time into the future (Gasaway et al. 1992).

Productivity

Calf production was higher in 1995 (21 calves:100 cows) than 1994 (16 calves:100 cows), but was still below the preceding 9 year average (24 calves:100 cows). More importantly, productivity is still well below the estimated 30-40 calves:100 cows needed to stabilize and slowly increase the population. For comparison, productivity for the Kobuk/Salmon Rivers survey area was estimated to be 55 calves:100 cows in 1995.

Mortality

Hunting mortality of radiocollared bulls has averaged 13% annually (1992-1995). Total mortality for all radiocollared moose for the same period has been 20-29%. The annual reported moose harvest in Unit 23 is probably ≥90% male. Furthermore, hunters select primarily older, larger size class bulls either by choice, regulation (i.e. spike fork/fifty), or both. The harvest pressure on large (i.e. ≥50 in) bulls has certainly deteriorated the bull:cow ratio since the mid-1980's when bull cow ratios from trend count data ranged from 31-56 bulls:100 cows. The 1995 survey data support the decreasing trend in the bull:cow ratio.

Survey Precision

The precision of the 1995 survey (i.e. ± 23%) was poor relative to the previous two years years (i.e. 1994 = ±12% and 1993 = ±12%). Overall precision of the 1995 population estimate was compromised by the mis-stratification of Units 16 and 26 which were stratified as "low" but in fact contained as many moose as a typical high density unit. Although precision was poor, the variance was reduced 22% by stratifying the units prior to the survey when compared to the results obtained if the data are analysed as a simple random sample. In support of the *a priori* stratification, Gasaway et al. (1986) stated that "even a poor stratification will likely improve precision compared to unstratified random sampling".

For responsive management, we strive for survey data that detect annual changes, but more often, the precision of survey data only allows for long-term trend analysis. The ability to detect population changes with a given statistical confidence is a function of the precision of the population estimates. Simply stated, the greater the precision, the smaller the change in population abundance that can be detected with each subsequent survey (Gasaway et al. 1986). Using the methods of Gasaway et al. (1986) and the Noatak survey data, we determined the precision required for subsequent Noatak surveys to detect population changes of 10-50% between surveys while varying the statistical confidence we have in our ability to detect the changes (i.e. $\propto$ and β)(Fig. 3). Because of the Middle Noatak Survey Area's small population size (_1,100 moose), it is evident, given the precision of the last 3 surveys, that detecting a change in population of only ≥20% annually is likely. If sampling variance is extraordinarily low (ie. V(Te) ≤ 5,000), then detecting a 15% change may be possible. For the western survey area, it may be necessary to sample as much as 40% of the sample units to obtain the required precision. This is equivalent to 9 cub-days (e.g. 3 cubs sampling 3 units/day for 3 days) of effort plus the stratification (i.e. 1.5 days). We presume that changes in population abundance greater than 30% should be noticeable by qualitative or observational data and subsequently supported by quantitative survey data. This was apparently the case following the winter of 1990-91 when moose density within the middle Noatak River area may have declined by nearly 50%, and local residents and agency personnel made numerous observations of heavy over-winter mortality. With these data in mind, we can evaluate the necessary sampling effort required for each subsequent survey to obtain statistically defensible population estimates with which to make management decisions. Furthermore, precision requirements equate directly to survey costs.

RECOMMENDATIONS

1. Complete a stratified, random sample survey of the Middle Noatak

Census Area every 5 years. The next census should be completed in Fall 1998. Strive to achieve a sampling variance to detect 15-30% change in the population with 80% probability.

2. Complete a stratified, random sample survey of the Western portion of the Middle Noatak Census Area annually with sufficient precision to determine a 30% change in the population between surveys with 80% probability.

3. Draft qualitative goals and quantitative objectives for the Noatak River/Noatak National Preserve moose population with agency and public participation.

Cost and Personnel

The cost to survey the western survey area, excluding personnel and ferry time for non-local charter cubs, was approximately $6,600.00. Local agency and charter aircraft were concurrently surveying the Upper Kobuk River Moose Census area and were not available to fly this survey. To complete this survey and the Kobuk/Salmon River survey within Kobuk Valley National Park, the NPS chartered 2 non-local cubs for an additional $2,584.00 (i.e. ferry time=17.5 hrs). For comparison, the 1994 survey cost $7,000.00. Agency personnel contributed 8 personnel-days of effort while pilots contributed 6. The 1994 survey required 22 personnel-days to complete.

LITERATURE CITED

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Table 1. Chronology, aircraft, and flight times for 1995 Noatak River moose census.

Date	Aircraft[a]	Hrs	Personnel	Activity
11/09	N3741Z	5.8	Hamilton/Shults	survey units
11/10	N3741Z	6.0	Hamilton/Shults	survey units
11/10	N8231E	7.0	Rood/Schnorr	survey units
11/11	N7063J	6.7	Dau/Ayres	survey units
11/11	N4627Y	5.8	Glaser/Shults	survey units
11/11	N3741Z	6.8	Hamilton/Peltola	survey units
11/11	N8231E	6.7	Rood/Schnorr	survey units

[a] N4627Y (PA-18); N7063J (PA-18); N3741Z (PA-18); N8231E (PA-18)

Table 2. Sample unit data for 1995 Noatak River moose census.

Unit	Stratum	Time (min)	Area (mi^2)	Bull[a]			Cow[b]			Calf	Total	SCF[c]	
				S	M	L	0	1	2			S	I
59	2	35	10.60	1	0	0	6	1	0	0	9	1	1
58	3	38	11.20	2	6	3	22	6	0	0	45	33	36
60	3	31	14.50	3	0	1	13	3	0	0	23	0	0
28	1	26	12.10	0	0	0	0	1	0	0	2	0	0
6	2	58	12.60	0	4	3	10	3	0	0	23	0	0
9	3	107	12.40	2	2	2	32	8	1	0	57	14	14
19	3	68	14.90	1	1	5	20	2	0	0	31		
114	2	53	13.50	0	1	0	4	1	0	0	7	0	0
87	3	29	11.40	0	1	0	1	0	0	0	2	0	0
115	2	24	12.10	0	0	0	0	0	0	0	0		
112	1	27	11.80	0	0	0	0	0	0	0	0	0	1
46	3	34	11.50	1	0	0	3	1	0	0	6	0	1
76	3	52	12.10	4	0	7	24	1	0	0	37	0	0
78	3	60	10.90	0	1	2	12	0	0	0	15	4	4
88	2	50	10.70	0	1	0	4	3	0	0	11	8	8
27	3	48	15.80	3	2	0	16	13	0	0	47	11	12
26	1	44	13.20	0	3	2	3	3	0	0	14		
56	2	47	11.90	3	3	2	22	5	0	0	40	13	14
15	3	27	13.60	0	0	0	0	1	0	0	2		
16	1	67	11.40	2	3	4	18	1	0	0	29		
2	3	52	14.50	2	4	3	24	1	1	0	38	2	3
74	2	45	13.30	0	0	0	0	0	0	0	0		
54	2	40	11.80	0	1	0	0	1	0	0	3	0	0
49	2	60	15.10	0	0	0	0	1	0	0	2	0	0

73	3	66	13.50	4	2	7	37	1	0	0	52	18	18
1	3	92	14.70	0	1	5	19	9	2	0	49		

[a] Bull antler size classes: S=small (<25 in), M=medium (26-50 in), and L=large (>50 in)

[b] Cow associations: 0=no calf, 1=1 calf, 2=2 calves.

[c] Sightability Correction Factor (SCF); "S" is the number of moose sighted during the standard search and "I" is the number of moose counted in the same area during the intensive search

Table 3. MOOSEPOP results showing estimated population size, density, sightability, and precision for the Middle Noatak moose censuses, November 1995 and 1994.

1995

PAR/STRAT	low	medium	high	TOTAL
N	23	28	17	68
Tot area	279.40	355.40	222.70	857.50
n	4	9	13	26
Area sur	48.50	111.60	171.00	331.10
# seen	45	95	404	544
Density	0.9278	0.8513	2.3626	1.3300
To	259.2	302.5	526.1	
V(To)	20012.14	11367.96	1787.75	
SCFo	1.000000	1.051152	1.070519	
V(SCFo)	0.0000000	0.0006805	0.0008108	
SCF df	9999	6	9	
To df	3	8	12	

Te= **1140.5** V(Te)= 34899.15 df(Te)= 8
80% CI around Te = (879.5, 1401.5) is +/- 22.88%
90% CI around Te = (793.0, 1488.0) is +/- 30.47%
95% CI around Te = (709.7, 1571.3) is +/- 37.77%

Moose Density = 1140.5 moose/857.5 mi^2 = **1.3 moose/mi^2**

1994

PAR/STRAT	low	medium	high	TOTAL
N	40	18	10	68
Tot area	491.90	229.30	136.30	857.50
n	4	5	8	17
Area sur	51.70	64.50	110.40	226.60
# seen	8	63	493	564
Density	0.1547	0.9767	4.4656	1.1657
To	76.1	224.0	608.7	
V(To)	1819.93	577.94	2781.96	
SCFo	1.000000	1.072257	1.122613	
V(SCFo)	0.0000000	0.0002359	0.0037044	
SCF df	3	2	6	
To df	3	4	7	

Te= **999.6** V(Te)= 7364.11 df(Te)= 10

80% CI around Te = (881.8, 1117.3) is +/- 11.78%
90% CI around Te = (844.1, 1155.1) is +/- 15.56%
95% CI around Te = (808.4, 1190.7) is +/- 19.13%

Moose Density = 999.6 moose/857.5 mi^2 = **1.2 moose/mi^2**

Table 4. Bull moose estimates calculated by MOOSEPOP, Noatak River moose censuses, November 1995 and 1994.

1995

PAR/STRAT	low	medium	high	TOTAL
N	23	28	17	68
Tot area	279.40	355.40	222.70	857.50
n	4	9	13	26
Area sur	48.50	111.60	171.00	331.10
# seen	14	19	77	110
Density	0.2887	0.1703	0.4503	0.2934
Wen	80.7	60.5	100.3	
V(Wen)	2113.29	613.67	89.71	
SCFo	1.000000	1.051152	1.070519	
V(SCFo)	0.0000000	0.0006805	0.0008108	
SCF df	9999	6	9	
df	3	8	12	

Wen= **251.6** V(Wen)= 2904.31 df(Wen)= 5
80% CI around Wen = (172.1, 331.1) is +/- 31.61%
90% CI around Wen = (143.0, 360.2) is +/- 43.16%
95% CI around Wen = (113.1, 390.2) is +/- 55.07%

1994

PAR/STRAT	low	medium	high	TOTAL
N	40	18	10	68
Tot area	491.90	229.30	136.30	857.50
n	4	5	8	17
Area sur	51.70	64.50	110.40	226.60
# seen	6	22	81	109
Density	0.1161	0.3411	0.7337	0.2953
Wen	57.1	78.2	100.0	
V(Wen)	1846.19	44.68	62.84	
SCFo	1.000000	1.072257	1.122613	
V(SCFo)	0.0000000	0.0002359	0.0037044	
SCF df	3	2	6	
df	3	4	7	

Wen= **253.2** V(Wen)= 2015.00 df(Wen)= 4

80% CI around Wen = (184.4, 322.0) is +/- 27.18%
90% CI around Wen = (157.5, 348.9) is +/- 37.80%
95% CI around Wen = (128.6, 377.8) is +/- 49.21%

Table 5. Cow moose estimates calculated by MOOSEPOP, Noatak River moose censuses, November 1995 and 1994.

1995

PAR/STRAT	low	medium	high	TOTAL
N	23	28	17	68
Tot area	279.40	355.40	222.70	857.50
n	4	9	13	26
Area sur	48.50	111.60	171.00	331.10
# seen	26	61	273	360
Density	0.5361	0.5466	1.5965	0.8567
Wen	149.8	194.3	355.5	
V(Wen)	8677.68	4991.90	836.29	
SCFo	1.000000	1.051152	1.070519	
V(SCFo)	0.0000000	0.0006805	0.0008108	
SCF df	9999	6	9	
df	3	8	12	

Wen= **734.6** V(Wen)= 15275.83 df(Wen)= 8
80% CI around Wen = (561.9, 907.3) is +/- 23.50%
90% CI around Wen = (504.7, 964.5) is +/- 31.29%
95% CI around Wen = (449.6, 1019.6) is +/- 38.80%

1994

PAR/STRAT	low	medium	high	TOTAL
N	40	18	10	68
Tot area	491.90	229.30	136.30	857.50
n	4	5	8	17
Area sur	51.70	64.50	110.40	226.60
# seen	2	31	365	398
Density	0.0387	0.4806	3.3062	0.7499
Wen	19.0	110.2	450.6	
V(Wen)	292.21	248.84	1887.42	
SCFo	1.000000	1.072257	1.122613	
V(SCFo)	0.0000000	0.0002359	0.0037044	
SCF df	3	2	6	
df	3	4	7	

Wen= **643.1** V(Wen)= 3705.00 df(Wen)= 8

80% CI around Wen = (558.0, 728.1) is +/- 13.22%
90% CI around Wen = (529.9, 756.3) is +/- 17.61%
95% CI around Wen = (502.7, 783.4) is +/- 21.83%

Table 6. Calf moose estimates calculated by MOOSEPOP, Noatak River moose censuses, November 1995 and 1994.

1995

PAR/STRAT	low	medium	high	TOTAL
N	23	28	17	68
Tot area	279.40	355.40	222.70	857.50
n	4	9	13	26
Area sur	48.50	111.60	171.00	331.10
# seen	5	15	54	74
Density	0.1031	0.1344	0.3158	0.1799
Wen	28.8	47.8	70.3	
V(Wen)	155.67	184.24	108.35	
SCFo	1.000000	1.051152	1.070519	
V(SCFo)	0.0000000	0.0006805	0.0008108	
SCF df	9999	6	9	
df	3	8	12	

Wen= **154.3** V(Wen)= 488.76 df(Wen)= 14

80% CI around Wen = (124.6, 184.0) is +/- 19.27%
90% CI around Wen = (115.4, 193.2) is +/- 25.23%
95% CI around Wen = (106.9, 201.7) is +/- 30.73%

1994

PAR/STRAT	low	medium	high	TOTAL
N	40	18	10	68
Tot area	491.90	229.30	136.30	857.50
n	4	5	8	17
Area sur	51.70	64.50	110.40	226.60
# seen	0	10	47	57
Density	0.0000	0.1550	0.4257	0.1204
Wen	0.0	35.6	58.0	
V(Wen)	0.00	199.11	33.03	
SCFo	1.000000	1.072257	1.122613	
V(SCFo)	0.0000000	0.0002359	0.0037044	
SCF df	3	2	6	
df	3	4	7	

Wen= **103.3** V(Wen)= 283.16 df(Wen)= 3

80% CI around Wen = (75.7, 130.8) is +/- 26.69%
90% CI around Wen = (63.7, 142.9) is +/- 38.34%
95% CI around Wen = (49.7, 156.8) is +/- 51.85%

Table 7. Bull:Cow ratios calculated by MOOSEPOP, Noatak River moose censuses, November 1995 and 1994.

1995

p= **0.3425** V(p)= 0.00084870 df(p)= 5

80% CI around	p	= (	0.2995,	0.3855)	is +/- 12.55%
90% CI around	p	= (	0.2838,	0.4012)	is +/- 17.14%
95% CI around	p	= (	0.2676,	0.4174)	is +/- 21.87%

1994

p= **0.3938** V(p)= 0.00561714 df(p)= 4

80% CI around	p	= (	0.2789,	0.5086)	is +/- 29.18%
90% CI around	p	= (	0.2340,	0.5535)	is +/- 40.58%
95% CI around	p	= (	0.1857,	0.6018)	is +/- 52.84%

Table 8. Calf:Cow ratios calculated by MOOSEPOP, Noatak River moose censuses, November 1995 and 1994.

1995

p= **0.2101** V(p)= 0.00108202 df(p)= 8

80% CI around	p	= (	0.1641,	0.2560)	is +/- 21.88%
90% CI around	p	= (	0.1489,	0.2712)	is +/- 29.13%
95% CI around	p	= (	0.1342,	0.2859)	is +/- 36.11%

1994

p= **0.1606** V(p)= 0.00063298 df(p)= 3

80% CI around	p	= (	0.1194,	0.2018)	is +/- 25.67%
90% CI around	p	= (	0.1014,	0.2198)	is +/- 36.87%
95% CI around	p	= (	0.0805,	0.2406)	is +/- 49.86%

Table 9. MOOSEPOP results comparing the 1994 and 1995 western survey area censuses with the complete 1993 census.

		1995	1994	1993
Population Estimate (80% CI)		1,141 (880-1,402)	1,000 (882-1,117)	1,125 (989-1,261)
Moose Counted		544	564	688
Area (mi^2)	857.5	857.5	1627.9	
Density		1.3	1.2	0.7
Bull Estimate (80% CI)		252 (172-331)	253 (184-322)	288 (235-341)
Cow Estimate (80% CI)		735 (562-907)	643 (558-728)	668 (583-753)
Calf Estimate (80% CI)		154 (125-184)	103 (76-131)	169 (142-196)
Bull:Cow Ratio (80% CI)		34 (30-39)	39 (28-51)	43 (36-50)
Calf:Cow Ratio (80% CI)		21 (16-26)	16 (12-20)	25 (22-29)
% of Units Counted		26/68=38%	17/68=25%	40/130=31%

Table 10. Moose sex and age ratios, and density, from trend count data in the middle Noatak trend count area. (From Dau et al. 1993)

Year	Total Bulls: 100 Cows	Lg. Bulls: 100 Cows	Calves: 100 Cows	Density (moose/mi^2)
1986	44[a]	18[a]	38	1.14
1987	56	23	44	1.23
1988	41	18	36	1.93
1989	35	7	11[b]	1.32
1990	31	8	31	1.84
1991	36[c]	17[c]	34	0.65
1992	31	10	7	1.17

[a] Wrench Creek not surveyed: the biologist who conducted this survey thought that a disproportionate number of bulls was missed by excluding this area (D. Larsen, pers. commun.)

[b] extremely high, prolonged flooding of major rivers occurred during breakup throughout Unit 23 which probably killed many calves

[c] increase in bull:cow ratios from 1990 to 1991 probably an artifact of disproportionately high overwinter mortality of cows relative to bulls (old bulls taken by trophy hunters whereas old cows accumulate in pop.)